Growing Our Own Food

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"Eat Vegetarian Fish"

My backyard family farm adventure.... started with a thoughtful friend saying something I had never heard before: "Eat vegetarian fish." Upon thinking about this, my world unraveled. Eventually it raveled again. (Is "raveled" the opposite of "unraveled"?) Well anyway, it came back together again leading to the idea of a Backyard Family Farm Kit. While still in its early chapters, I would like to bring this possibility to your attention.

In the summer of 2007, I visited my friend Jesse Ausabel on Cape Cod to discuss building open libraries in the digital age, but as I was leaving I asked him about the state of life in the seas. He is a good person to ask this particular question because he started a project in the year 2000 to count all the fish in the sea, called the Census of Marine Life. As if that weren't hard enough, he wanted to know how these populations change over a decade. The project now involves thousands of people from 80 countries. It is from this project that we have seen a stream of stories about the virtual disappearance of different kinds of fish, such as the Atlantic Bluefin Tuna.[1]

When I was growing up, tuna was the "chicken of the sea." Now it is being massively overfished. As Jesse put it, it is a bad time for any fish that is either large or delicious. Almost all fish that are large or delicious are in serious decline; many populations are down over 90% from a century ago[2]. Jesse Ausabel is the kind of scientist who thinks hard about what he says and one of those people who, if I listen carefully enough, and I think hard enough about what he says, it leads to more interesting insights. The problem, he said, is that people are eating too much fish. From a personal perspective, I remember when I was growing up that salmon and lox were expensive delicacies but now they are served in vast quantity. Salmon has been available for under $5 a pound at Wal-Mart.[3] Jesse said that commercial fishermen are now "hoovering up the seas" with vast trawling nets.

Always the technology optimist, I asked about farmed fish. I had heard of problems with the vast salmon farms off the coast of Chile—the environmental impact of the fish waste, the problems with the farmed fish escaping and affecting the native populations, the antibiotics used on diseased farmed fish thereby exposing unprotected native fish to diseases and wiping them out...But I had recently been fed some fish presented by a dot-com millionaire from some venture he was funding to farm fish in pens in the deep Pacific Ocean and this

was touted as a great solution. Can we find our way through this overfishing wild fish problem with farmed fish?

He said farming fish might work, but he pointed out a problem that I had never heard of before—he said that most farmed fish eaten in the United States are carnivorous. They eat other fish. These other fish, such as anchovies, herring, and sardines, are generally caught in the wild to be fed to the farmed fish. So now we are harvesting wild feeder fish for the farms. Diminishing those wild fish populations ripples through other wild fish populations, and we have the problem he was talking about. Three pounds of feeder fish are used to fatten a salmon by one pound. And a 3-pound fish yields roughly one pound of fillet. Therefore, approximately nine pounds of sardines are needed to make one pound of fish fillet in the supermarket. Jesse said that either we have to trick our carnivorous fish into eating tofu (soybean flavored with fish) or, as he put it, we have to "eat vegetarian fish".

I was puzzled. I had not heard someone ever talk about vegetarian fish before. He said that carp, catfish, scallops, tilapia and others are vegetarians—instead of eating other fish, they eat algae or other kinds of muck that is lower on the food chain. Farming these types of fish might have other problems, but they won't eat the world out of wild fish. I thought about the land animals we eat, and that they are all vegetarians—cows, chickens, pigs, and turkeys. There are some people that eat dogs and cats, which are carnivorous, but they're not the majority. This was intriguing to me.

So I started to learn more about the food I eat. I read Fast Food Nation, Omnivore's Dilemma, and Grow More Vegetables; watched *SuperSize Me*, *Future of Food*, *King Corn*, *Drop of Life*, *Raw for 30 Days*, and *An Inconvenient Truth*. The issues being raised are large, but seemingly interrelated. Excess corn production, deforestation, global warming, obesity, oil dependency, clean water shortages, and depletion of the soils. Our decision-making structures over the last century have led to vast increases in population and ecological strain.

The commoditization of food and the mass farming of the "green revolution" may have created much more food, but it also may have had an unattended consequence. Most of us have lost touch with where our food comes from and how our choices in our supermarkets lead to rippling effects that are reshaping the biosphere. Most of the grains we eat in the United States come from almost unpopulated farms that many of us will never see except from thirty thousand feet in the air. The vegetables and tubers come from farms that employ migrant workers that most of us will never meet. In other words, we do not grow our own food nor do we know who does, which could be a reason many of us eat too much and many unhealthy foods.

Maybe we could change that. Maybe we could get back in direct contact with food production by developing a locally self-sustainable food system that would not require a radically different lifestyle from that we have come to enjoy. Inspired by the experiments in the 1980's at the New Alchemy Institute on Cape Cod, I wondered: Could we make a "backyard family farm" that would feed a

family of three in an ecological and economical way?

Based on reading agricultural studies and early conversations, a couple of names kept coming up, John Jeavons and James Rakocy. I set out to find them and learn from them. What they have accomplished astounded to me.

John Jeavons' Sustainable Farm

John Jeavons[4] is a leader in sustainable farming based on his continuous research and development over the last 40 years. His work became a foundation of the teachings at the University of California Santa Cruz's agriculture program.[5] He started to farm on borrowed land in Palo Alto, California in the 1970's but has since moved north to Willits, California to farm on a difficult hillside property that he owns. Even with challenging land, his research has achieved remarkable results. Reading his works and then attending a workshop and open house, I was able to help him farm on his property and discover first-hand how one can live off the land with very few "inputs".

"Inputs" is the name for all the extra supplies needed from outside the farm. Most farms import at least seed, fertilizer, labor, petroleum, farm equipment, and water from outside of their farm in addition to sunlight and fresh air we take for granted. John Jeavons' farm has brought this list down to just labor, rainwater, and a few manual farm implements. He has shown that a person can live on the vegetarian diet supplied by 2000 square feet of land, so a family of three could feed itself year-round farming 6000 square feet or about an eighth of an acre.[6] He allocates and rotates each growing bed carefully to grow the right mix of fruit, vegetables, natural compost, and natural pest repellants. With this tight engineering he has achieved a self-sustainable farm even on difficult farmland.

To the extent there is a downside on his approach, it is that it is labor intensive and does not support meat, for those that want that. With that understanding, I looked for models for people solving those issues as well.

Raising of Fish and Vegetables Symbiotically

Professor James Rakocy has devoted his 28-year career to developing a system that is not as self-reliant as John Jeavons' but has achieved highly productive and diverse food growth on a small plot in a way that could greatly reduce the required labor. To spread his ideas he offers students an opportunity to learn and copy his ideas. My family took a 10-day intensive course at his experimental agricultural station at the University of the Virgin Islands in the summer of 2008 to learn his techniques. Attended by 40 other people from all over the world, we learned just how much one could grow on an eighth of an acre.

The idea is to grow fish and vegetables symbiotically such that the waste products of the fish are turned into fertilizer for the vegetable garden. The fish excrete nitrogen, which fish farmers find a big problem to deal with, but nitrogen is the basic component of plant fertilizer. In fact the nitrogen production facilities used for armaments during World War II were repurposed[7] to make fertilizer, which partially lead to the "Green Revolution" that increased crop production greatly.[8] In this case the nitrogen excreted from the fish is leading to very productive crop yields. The nitrogen is converted from the ammonia from the fish to nitrites and then to nitrates for the vegetables using biologic processes that are very efficient and ecologically friendly.

The vegetables are then raised hydroponically such that they are held above a trough of water and their roots dangle into the water. This form of "dirty" hydroponics differs from most hydroponics in that it has many more natural life forms in the water and environment, which makes it easier to maintain, and possibly more nutritious.

Growing fish, of aquaculture, combined with hydroponic vegetables, which Professor Rakocy calls "aquaponics" has some remarkable features.

The resulting eighth-of-an-acre system that they have developed and have reproduced elsewhere has the astonishing yearly yield of eleven thousand pounds of fish and fourteen thousand pounds of vegetables. This takes fish feed that is supplied from external sources, small amounts of chemicals, and it also takes 450 gallons of water per day. While this water use may seem high, it is approximately the water used by an average family of three in the United States.[9] It is also more efficient with water to grow hydroponically than dirt-based vegetable farming because the only water loss if through transpiration through the leaves—all else is re-circulated.

The labor required maintaining this aquaponics system could be less than that requires by a dirt based systems because of the plant and fish based environment can be effectively monitored and controlled, as well as that there is no weeding needed. The systems have to be monitored on a daily basis, but the Jim Rakocy's team estimated that one person could tend to 8 of these 1/8th acre systems most of the time. So conceivably, one person could work an hour each day, and more on some harvest or planting days, and tend such a farm. The harvesting can be that rotated so the labor needed can be evened out. This system does require more care and controls than a traditional farm, but the results are spectacular.

Eleven thousand pounds of fish and fourteen thousand pounds of vegetables from an eighth of an acre would feed many families.

Figure 1 Fish Side of 4-tank System

Figure 2: Vegetable Side of 4-tank System

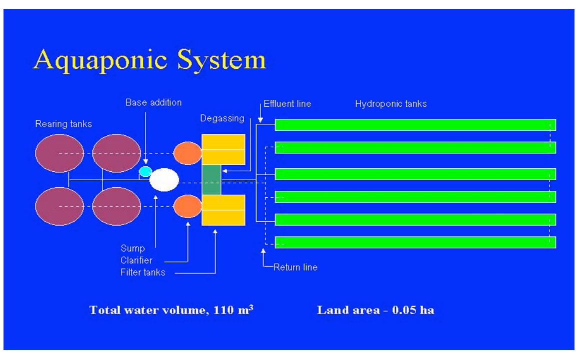

Figure 3: 11,000lbs of Fish 14,000lbs of Vegetables

Figure 4: James Rakocy and Hydroponic Roots

Backyard Family Farm

What if we could grow our food locally? As an extreme, what if we could grow all the food we need in our own back yards? While maybe not what most people would want to do, if a few people in each community were to grow their own food, then others would learn from them and could apply their new knowledge to their buying decisions to effect large-scale change. Also, larger but still small-scale farms could evolve on the outskirts of towns and cities bringing many of the benefits of connecting citizens to their food. I set out to try a thought experiment—what if we could feed ourselves from a Backyard Family Farm? And could this be made into a kit such that many people could set up Backyard Family Farms for themselves. By building on the work of John Jeavons, Jim Rakocy and others, I believe it now possible and even desirable. Best yet, it may not be overly difficult to build some test environments.

What would it take to make a successful backyard family farm?

- One hour of work a day per person or less,
- Supports all the food of a typical family of three,
- 1/8 of an acre,
- Vegetables, fruit, fish, chicken, maybe grains,
- Low fuel costs: almost completely solar powered for heat, electricity, and growing,
- Low groundwater use: almost completely run off of rainfall or maybe gray water use, and
- Applicable in many geographic areas.

If we could accomplish most of these goals we could have a replicable model for food production and food production awareness. To say a bit about where these goals come from and how they might be achievable lets start with the first one, which is the labor target.

Talking with friends that have gone into organic farming, they have said that it's hard work and has lead to burnout. We have to make this easy enough to not be a full time job. What if it would take 1 hour per day, per person to tend one's garden? Since families average about 1/10 of their income on food[10], and 1 hour is 1/8 of the average workday, then we would be spending about the equivalent amount of our time on the farm, rather than the earning money needed to buy food at a store. An hour a day would keep one in contact with ones food, get some productive exercise, and build confidence in self-reliance. Even if one loses one's job, one would still have food.

Supporting all the food needs of a family of three is attainable, but Americans have grown accustomed to a very wide variety of food choices. So if this farm were able to achieve the goal, but the family could afford to eat out occasionally or knows other farmers for swapping, we could achieve similar levels of diversity we currently enjoy. I have heard there is an active barter system among

farmers at farmers markets. If applied to backyard family farmers, this barter system would build relationships that can further secure our food supply against shortages or crop failures.

An eighth of an acre is a very small farm. A 75 x 75 foot area[11] is about ½ of the suburban plots in many areas[12]. But we have reason to be optimistic based on the aquaponics' and John Jeavons' systems. The aquaponic system does not grow grains and requires external inputs, but it produces much more than a family needs.

A "typical family of three" is used here rather than the "family of four" because the average United States household size is, in fact, now only 2.61 people[13]. There is nothing in the Backyard Family Farm that would not work for more or fewer people, but some of the parameters might have to change.

Further, many lands lend themselves to better farming of certain plants than others—is there a way to grow a variety of foods in one place, and then can we use a wide range of locales for these farms? By following some of the techniques already explored, the answer is yes. Constructing a green house around our farm would make it more applicable to more environments.[14]

If our family is to have the regulation amount of protein from fish alone, then we need approximately a pound and a half of fish per day[15]. This can be supplied by a tank that is 10 feet by 75 feet of Tilapia[16]. Tilapia is the second most farmed fish in the world, after carp, and can grow in small-scale ponds like this. Unfortunately, some regions such as Northern California, regard it as an invasive species, so it cannot be farmed everywhere. Different fish species can be farmed, and farmed together. Polyculture fish farming has worked for mixing tilapia and catfish, tilapia and carp, tilapia and shrimp, and catfish and paddlefish. Maybe we could have a large number of different fish in the pond. This could keep the families interest in caring for the fish and in eating the fish.

Chickens, ducks, geese could add a source of eggs, meat, entertainment, as well as, fish food. Keeping chickens in greenhouses has the added benefit of helping with temperature regulation.[17] Where factory farmed chicken is slaughtered sooner, "free-range" chickens are often slaughtered at 14 weeks[18]. A productive hen can lay 300 eggs a year, so maybe the farm should have 2 chickens. Chicken waste is commonly fed to fish in pond-based fish farms in Asia.

On the subject of water use, this farm might be able to live just off of rainwater! If this were true, this could be a huge boon in water conservation as current farms use rivers and underground aquifers extensively. To see if this would work here, lets do a few calculations. The average California rainfall is 17 inches per year, 20 inches in San Francisco, 35 inches in the farm country north of San Francisco. The fish tank could be used as a cistern to catch the rain. Assuming the middle of the rain estimates, we would get about 200gallons/day just from rain.[19] Then there is amount of recycling of household gray water that could be done. Based on the water-use of the larger-than-needed aquaponics system, running our farm on 200 gallons could be feasible.

While some electric power will be needed for pumps and controls, the majority of the energy can come directly from sunlight for the plants and keep the farm warm. It is plausible that this farm would not need much external fuel.

So it is plausible that a Backyard Family Farm could achieve our goals and be a success. There would be significant research and development needed, but it seems possible. The benefits to the individual family, the community, and if copied, the world are significant.

For instance, we might be able to help our current environmental degradation by going to an intensive farming structure like this. The current land used to feed a US family is about 6 acres[20]. If we even reduce this to one acre, then the US could generate $200 billion a year in export revenue (about 10% of the total federal tax revenue), or we could return 600 million acres to prairie and forest—the equivalent of 3 times the Louisiana Purchase.

Based on pioneering work on sustainable and small-scale agriculture we could have a system that can feed ourselves, educate ourselves, and return most of the land and water resources to their pre-human equilibrium. Lets eat.

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[1] **http://en.engormix.com/MA-aquaculture/news/census-marine-life-historians_10838.htm**

[2] Summarizes several studies http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1569453

[3] http://www.salon.com/tech/books/2006/01/23/walmart_effect/index.html

[4] http://www.johnjeavons.info/

[5] Based on a conversation with a graduate of the program, Lawrence Jaffe.

[6] http://www.wolframalpha.com/input/?i=6000+square+feet+in+acres

[7] "During the war, nitrogen was one of the prime components of TNT and other high explosives, and the U.S. government built 10 new plants to supply nitrogen for bombs. After the war, those plants produced ammonia for fertilizer. Fertilizer use exploded, in part because the supply was there and in part because farmers and scientists understood how important nutrients were to crops." http://www.livinghistoryfarm.org/farminginthe40s/crops_04.html

[8] http://en.wikipedia.org/wiki/Green_revolution#Technologies

[9] http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_the_United_States

[10] http://www.ers.usda.gov/publications/aer780/aer780e.pdf

[11] http://www.wolframalpha.com/input/?i=square+root+of+%28square+feet+in+1%2F8+acre%29

[12] http://en.wikipedia.org/wiki/Quarter_Acre

[13] As of 2006, according to the census the average household size is now 2.61. http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=&geo_id=01000US&_geoContext=01000US&_street=&_county=&_cityTown=&_state=&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=010&_submenuId=factsheet_1&ds_name=DEC_2000_SAFF&_ci_nbr=null&qr_name=null®=&_keyword=&_industry=

[14] This paper describes a greenhouse that costs $5700-8400 for a 342 square meter greenhouse, so if this were placed over the 1/8th of an acre farm at the same cost per square foot, that would be under $12,500 http://www.scribd.com/doc/49262/A-lowcost-energy-efficient-greenhouse-construction-manual http://www.wolframalpha.com/input/?i=%28%248400+per+342+square+meters+in+dollars+per+acre%29+*+1%2F8

[15] Protein needs for a family: Northwestern University suggests 0.8 grams per kilogram of bodyweight or 1.17 oz per 100 pounds or less than 5 oz's per day for our family. For every 100 grams of raw tilapia, we get 20 grams of protein for the eater. So 25 oz's a day of tilapia would have to be eaten by our family to get the right amount of protein. This corresponds pretty well to the 20 oz's of meat/beans suggested by the USDA.

[16] Since Tilapia grow up in 270 days (http://pdacrsp.oregonstate.edu/pubs/engle_manual.pdf) or ¾ of a year, then we need 270 Tilapia in our farm to source one Tilapia a day if they all survive. With a 90% survival rate (ibid) we would need 300 fish. We can farm 3 fish per square meter (ibid), or 1.5 kg/sq-meter (http://www.fishfarming.com/tilapia.html). The New Alchemy solar ponds (http://www.vsb.cape.com/%7Enature/greencenter/pdf/solaraqua.pdf) have about this density of 40 pounds of fish per 5' diameter by 5' deep round tank 7.2 square meters, or 2.5kg/sq-meter. With, say, 30 fish per 7.2 square meters we would need 72 square meters of tank, or a tank 10 feet by the 75 foot width of the farm.

[17] http://www.themodernhomestead.us/article/Chickens+and+Worms.html

[18] http://en.wikipedia.org/wiki/Chicken

[19] 2 feet of rainfall over 1/8 acre of land divided by the number of days in a year is 223 gallons. http://www.wolframalpha.com/input/?i=%282+foot+acres+in+gallons%29+*+1%2F8+*+1%2F365

[20] This is calculated from totaling "382 million acres is used for crop production" (http://www.epa.gov/agriculture/ag101/landuse.html) and "525 million acres" (http://www.epa.gov/agriculture/ag101/landuse.html) for livestock which is a total of 907 million acres, of which ¼ of our revenues are generated from export (http://www.epa.gov/agriculture/ag101/econrevenues.html), so maybe ¾ is eaten domestically, or 680 million acres goes to feeding the domestic population. 300 million people in the US and 2.61 in your typical household, so there are 114 households or so the average is about 6 acres per family. (http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=&geo_id=01000US&_geoContext=01000US&_street=&_county=&_cityTown=&_state=&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=010&_submenuId=factsheet_1&ds_name=DEC_2000_SAFF&_ci_nbr=null&qr_name=null&reg=&_keyword=&_industry=)

Batteries that store Heat and Cold: Thermal Batteries

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Who among us would voluntarily raise their floor by 2 inches (thereby losing as many inches of height) in exchange for a cost-effective new way of heating and cooling our house? I would, and let me tell you why.

For those of us who live in a place where it gets cold at night and hot during the day—like most places in the desert—we all feel the pain of spending money on heating and cooling bills to stay comfortable. According to the U.S. Department of Energy, heating and cooling account for about 56% of the energy use in a typical U.S. home, making it the largest energy expense for most homes.

But what if there were a “thermal battery” powered by changes in the outside air temperature that could be installed in a house that would store the night-time cold for daytime use, and vice versa? It wouldn’t cost anything to run, and it would cool and heat the house at the appropriate times.

Such a technology exists[1], is could be simple to install, and I believe, cost effective. It has been in development for more than 30 years, and with our renewed interest in saving energy, we might now have the opportunity to deploy it.

It is based on what is called “phase change materials”—materials that solidify at a particular temperature. There are two materials that have that have convenient melting points and have been used in this type of application: an eutectic salt—a salt that melts easily—and a waxy compound made from oil[2].

Ice and water provide a convenient illustration of how such materials work. When ice is heated it stays at the melting temperature of 32 degrees as it takes a lot of energy to turn it all to water before it will start rising in temperature again. Similarly, when water is cooling, it will stop at the freezing temperature, giving off lots of energy, until it is all frozen and then cool further. In this way, water will give off heat as it freezes or give the surrounding environment as it thaws—always trying to maintain 32 degrees until it all changes phase. If we have a half-frozen substance, then it will try hard to maintain its freezing temperature.

Where water solidifies at 32 degrees Fahrenheit, we could have an alternative liquid that “freezes” at, say, 70 degrees Fahrenheit. This alternative substance would try to keep the temperature at 70 degrees.

If we could put enough of this new substance on the floor, ceiling, or walls of a house, it could put out enough heat or cold when needed, then be “recharged” at

night and during the day.

Calculating how much is needed and how much it will cost for a typical house is tricky, but let's try. The average home heating bill is about $1,000 per year[3]. To be able to "produce" this much heat would require enough material[4] to add 2 inches of height to the floor if spread evenly over 2,000 square feet[5]. The wax would cost $10,000[6]. If it was used just for heating, and it replaced the fuel bills, then it would pay for itself in 10 years. There are installation costs that would bring up the costs, but this same system would offset cooling bills in the summer, and provide extra savings there.

Overall, 39% of our energy goes into heating, cooling and lighting of all buildings[7] -- commercial and residential—which means that if we could reduce the energy used in the heating and cooling parts by 50% (and LED and compact fluorescent lights could help with the lighting part), then the energy use in the United States would go down by almost 20% or as much energy as the United States uses from coal.[8]

So thermal batteries might be a technology, if widely deployed, that stabilizes the temperature in our houses, saves us money, and helps reduce greenhouse gases.

Are we ready for this technology? I believe we are. Renewed attention to energy consumption is spurring the government to invest in new technologies. And in recent years we've seen populations grow in the deserts of Arizona, New Mexico and California[9] so there are many that would benefit from straightforward applications of this technology. Besides, it would both save money and be green.

General bibliography:
Phase Change Material Research page
http://freespace.virgin.net/m.eckert/index.htm

http://en.wikipedia.org/wiki/Thermal_energy_storage

[1] http://www.allanstime.com/SolarHome/#5.
[2] phase change materials in buildings overview 2006:
http://www.ornl.gov/sci/roofs+walls/staff/papers/78.pdf Kissock et al. (1998) reported that wallboard, including a paraffin mixture made up mostly of n-octadecane, which has a mean melting temperature of 24°C (75°F) and a latent heat of fusion of 143 kJ/kg (65 Btu/lb), "was easy to handle and did not possess a waxy or slick surface. It scored and fractured in a manner similar to regular wallboard. Its unpainted color changed from white to gray. The drywall with PCM required no special surface preparation for painting." In addition,
Salyer and Sircar (1989) reported that during tests of 1.22×2.44 m (4×8 ft) wallboard with PCM, there was insignificant loss of PCM after 3 months of exposure to continuously cycled 37°C (100°F) air.

"The capability of PCMs to reduce peak loads is also well documented. For example, Zhang, Medina, and King (2005) found peak cooling load reductions of 35 to 40% in side-by side testing of conditioned small houses with and without
paraffinic PCM inside the walls."

[3] http://www.washingtonpost.com/wp-dyn/content/article/2008/03/15/AR2008031502334.html
Home heating energy use estimate: 140,250kBtu per year, cost $1,122
http://www.rockymtnashrae.com/wp-content/uploads/2008/08/newcapbriefing.ppt

[4] $1,000 in energy at current prices is about 140,250kBtu per year. Spread over a 4-month period (say the hottest time of the summer or winter), it is 1130kBtu/day. With the paraffin substance that stores 65Btu/lb, we would need 17,000 pounds of it.

[5] paraffin weighs 0.819g/cubic-cm http://www.wolframalpha.com/input/?i=+paraffin
28k cm**3/ft**2 http://www.wolframalpha.com/input/?i=cubic+foot+per+cubic+cm
23k g/ft**3, 453g/pound http://www.wolframalpha.com/input/?i=grams+in+a+pound,
or 50lbs/ft**3. We need 340cubic feet of paraffin, or if more than 2,000 sq feet of floor, then 2 inches.

[6] Paraffin costs 900 Euros/ton http://www.icis.com/StaticPages/Paraffin_Wax.htm
http://www.icis.com/Articles/2009/09/04/9245370/Raw-material-increases-push-oxos-and-plasticiser-spot-prices.html or $0.58/lb
http://www.wolframalpha.com/input/?i=900+euros+per+tonne
17,000 pounds would cost $10,000.

[7] Building consume 39% of the energy used in the United States
http://www.theatlantic.com/doc/200907/carter-obama-energy
UK residential buildings consume 27% of the final energy consumption
http://freespace.virgin.net/m.eckert/final%20maastricht.pdf

[8] US Energy use is 100quadrillion BTUs/year in 2005, 23% from coal.
http://en.wikipedia.org/wiki/Energy_use_in_the_United_States

[9] Phoenix Arizona's high/low temperature history shows a that it almost always gets over 72 degrees F during the day and below 72 at night:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KAZPHOEN84&day=27&year=2009&month=9&graphspan=year

Use of solar concentrators can extend the usefulness of this technique into cooler climates because concentrated solar energy will create a hotter than ambient environment to melt the phase change materials.

Dallas Texas looks like it could work well:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KTXDALLA46&day=27&year=2009&month=9&graphspan=year

Areas of Florida, such as Naples, appears to look good for this technology:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KFLNAPLE17&day=28&year=2009&month=9&graphspan=year

Las Vegas shows less of a split in high/low around the human comfort point:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KNVHENDE6&day=27&year=2009&month=9&graphspan=year

Fresno, California looks like a good candidate:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KCAFRESN10&day=29&year=2009&month=9&graphspan=year

The World Needs eBikes

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If you go to Beijing these days, you won't see gas-powered bicycles or Vespas. But you will see a lot of people riding around on electric bikes that look like small scooters with pedals.

Last June, shortly after we arrived in Beijing for a five-week stay, my wife went out to buy four bicycles for the family, and came back instead with a brand new eBike that cost less than $300. It was so easy to use that she rode it home. Still better, she needed no license or insurance. And she could park it anywhere.

A brief description: like a Vespa, the eBike has a comfortable seat for the rider, and another for the passenger. A large basket makes it usable for going to the market, or in my case, back and forth to my office at the University. Powered by

an in-hub motor and a heavy lead-acid battery, the bike can go faster than the other bikes on the road but slower than the cars. We traveled on the road, but with the other bikes. Our eBike came with a built-in locking mechanism, so there's no need for a separate chain. While our battery lasted for several days between charges, our average speed was around 15 miles an hour (I routinely passed bicycles.) The one problem is steep hills; you need to pedal.

I was told there was no law that forced Beijing residents to give up their gas-powered equivalents. People just started riding the eBikes. (Isn't it ironic that a city known to be one of the most polluted on the planet is one of the forerunners in a clean, fast, safe, small and highly efficient conveyance?)

I heard that 100 million eBikes have been sold in China by dozens of companies offering dozens of variations each on the eBike theme. Look around Beijing and you'll have trouble finding two eBikes that are exactly alike. This technology is in high-speed evolution. I wonder if the reason why China has developed and adopted this technology so fast is because they need a less expensive way to get around their crowded cities. The United States may have missed the boat on this because it is too wealthy, at least too wealthy right now.

We quickly fell in love with our eBike and rode it everywhere. And that got us thinking about bringing it back with us to San Francisco.

Of course, it wasn't so easy. Needless to say, it wouldn't fit in our luggage, and there were some questions about transporting a large battery. It got so complicated that we eventually gave up, and gave it to a Chinese graduate student who had been very helpful to us during our stay. He was thrilled.

And it turns out that where eBikes cost $300 in Beijing, an eBike in the U.S, while different[1], costs about $1,500. Part of the difference may be our mindset. We tend to think of such a thing as either an enhanced touring bike that can propel us to the top of Mt. Tam, or a motorcycle for freeway driving. But an eBike, like the one we had in China, is a more practical utilitarian device that can be used for commuting (okay, not over the San Francisco-Oakland Bay Bridge), but it can be used for tooling around the city.

Attempts to revolutionize urban transportation—and thus the structure of cities—with personal electric vehicles aren't new. In 2001, Dean Kamen (with the endorsement of Steve Jobs and Jeff Bezos) launched the Segway Human Transporter, a two side-by-side wheeled, gyroscopically stabilized standing-scooter. By the time it launched, Kamen has raised more than $90 million from investors, and predicted to Time magazine the Segway "will be to the car what the car was to the horse and buggy."[2]

Now the Segway is a curiosity in a few airports and tourist areas. The $5700 price tag, the 80-pound weight, regulations about where it could be ridden, and its sheer complexity may have kept the Segway from reaching the mass market.

But the arguments about the Segway—that personal, quiet, electric urban

transportation could reclaim cities from the automobile at the same time as expanding the range of travel for city dwellers and weaning society from fossil fuels—are still valid. It's just that now it can be done for 1/20th the price and a more familiar method: a bicycle.

So there's no reason we shouldn't be seeing electric bikes all over the place in the U.S.

There are several ways these bikes may be integrated with existing urban transportation systems. For example, bike share programs have been very successful in European cities, including Paris, London, Stockholm, Barcelona, Geneva, and Rome; the Copenhagen city center has 2500 bikes available for short-term rental. Sometimes tied to other regional transportation services, these rental programs operate under a variety of economic terms. But what they have in common is intent, at the societal level, to improve the quality of urban life while reducing environmental problems.

If eBikes were embraced in San Francisco—to name my own city—the same way they have been embraced in Beijing, we could transform the city. If one out of every five car-drivers switches to an eBike, we could speed up general traffic, ease parking issues, and get people out and about more. Most of the time, when I get in my car, I could just as easily have used an eBike. Better yet I might be more inclined to buzz around to different parts of the city rather than stick to my neighborhood because I worry about finding a parking place or the inconvenience of public transit.

If you want to go out tomorrow and buy an eBike, you should know that they are regulated as bicycles as long as they satisfy a few criteria: their motors can't be too powerful (i.e. more than 1 horsepower or 750 watts), they need to have working pedals and they can't go over 20 miles per hour. California adds a few extra restrictions:[3]The rider must wear a helmet and be 16 years of age.

I especially like a bike from e-road[4]for $900, plus $100 for shipping.

[1] http://myebike.com/
[2] Reinventing the Wheel, By John Heilemann Sunday, Dec. 02, 2001
http://www.time.com/time/business/article/0,8599,186660,00.html

[3]http://en.wikipedia.org/wiki/Electric_bicycle_laws#Comparison_of_state_rules_and_regulations
[4] http://www.e-road.com/products/electric-bike